

An ECO-LOGICAL Way to Dispose of Waste

Managing toxic waste is one of the country's biggest industrial and environmental headaches, but technology is right around the corner that may make the process safer, cleaner, and eventually cheaper than incineration.

Eco-Logic International, Inc., based in Michigan and Canada, has developed a process that can completely destroy organochlorines and organic matter, including compounds such as PCBs, dioxins, furans, and chlorinated pesticides. The company's patented gas-phase thermochemical process uses a reduction reaction of hydrogen with organic and chlorinated organic compounds at elevated temperatures. Hazardous contaminants are transformed into excess hydrogen, methane, and a small amount of water vapor. The gases produced in the reaction either recirculate into the process or provide supplementary fuel for the system. And because it is a closed-loop system, no contaminants escape.

Currently, incineration is the method of choice to dispose of municipal, medical, and hazardous waste, but evidence indicates that this technology is flawed and may create more problems than most communities are equipped to handle. Under high-temperature combustion, organic compounds containing carbon, hydrogen, and often chlorine are oxidized. Other substances potentially incinerated include sulfur, arsenic, and metals such as chromium, mercury, and lead. Both the toxic emissions produced during the burning process (sometimes from acci-



The "Destructor." Organic compounds such as PCBs, dioxins, furans, pesticides, and solvents are destroyed by this process.

dents) and toxic ash left over after combustion are often more hazardous than the original materials. These emissions consist of products of incomplete combustion, escaping heavy metals, and new combinations of materials as a result of the burning process. The fly ash—the particulate matter emissions which may include dioxins and

70% of the airborne dioxin deposited in the Great Lakes comes from the incineration of municipal and medical waste. Another 20% comes from certain steel mill operations and the burning of hazardous waste from within 300 miles of the lakes to as far away as 1,250 miles.

Toxic releases are insufficiently tested and can pose health hazards. The EPA Dioxin Reassessment states current exposures to dioxin carry a cancer risk of 1 in 1,000 to 1 in 10,000. A Harvard University School of Public Health study indicates that air pollution, especially fine particles from combustion of fossil fuels, including incinerators, may result in roughly 60,000 deaths each year, and that tens of thousands, especially children, are made sick.

Grinding Heat

At 850°C or higher, hydrogen combines with organic



On the road again. A mobile system means communities can avoid the divisions and dangers that come with incineration siting.

contaminated compounds in a reaction known as reduction, producing lighter, smaller products. Water, which can serve as a reducing agent and a source of hydrogen, enhances the reaction. And because hydrogen can produce an atmosphere devoid of free oxygen, the possibility of dioxin or furan production is eliminated. Wastes suitable for this kind of destruction include contaminated soils and landfill leachates, lagoon and harbor sediments, wood treatment and pulp mill wastes, contaminated electrical equipment, pesticide wastes, chemical warfare agents, and organic wastes mixed with low-level radioactive wastes.

When treating high-concentration organic wastes, the process produces excess gas, which can be compressed and stored for later use, either as boiler fuel or as a fuel product for resale. Although the technology does not treat metals such as mercury, copper, iron, and cadmium or nuclear waste, it may be used to separate these various materials from organochlorines.

The Eco-Logic technology is the brainchild of Douglas Hallett. Hallett spent 16 years with Environment Canada, part of the time as senior scientific advisor, where he worked on both the Great Lakes and Love Canal. In 1987, Hallett founded Eco-Logic International to develop and commercialize the initial concept he conceived in 1985. Wayland Swain, former EPA director of the Large Lakes Laboratory in Grosse Ile, Michigan, heads the U.S. operations.

A laboratory-scale process unit was constructed in 1988 and tested extensively. Because the results were so favorable, a mobile demonstration-scale unit was constructed and commissioned in 1991. The unit was taken to Hamilton Harbour, Ontario, where coal tar-contaminated harbor sediment and PCBs were successfully processed. The results were audited by the Waste Water Technology Center, formerly part of Environment Canada. The Ontario Ministry of the Environment also participated in the audit. The results confirmed consistent destruction efficiencies of 99.9999% or better on coal tar-contaminated sediments dredged from the harbor.

During October and November 1992, the same unit was taken through a second round of tests for 28 days as part of the U.S. EPA's Superfund Innovative Technology Evaluation (SITE) program in Bay City, Michigan. The agency conducted extensive tests, treating wastewater containing an average 4,600 parts per million PCBs and waste oil containing an average 24.5% PCBs. Both wastes were tested in triplicate. A specific quantity of perchloroethylene (PCE), a reliable surrogate

measure for PCBs, was added to the waste stream as a control, and the unit was put through a 72-hour engineering performance run.

According to an EPA report on the test, the technology was quite effective: "A 99.9999% destruction and removal efficiency for PCBs during all the test runs; a 99.99% destruction efficiency for perchloroethylene; net destruction of trace feedstock dioxin and furan compounds during all test runs; and successful completion of a 72-hour engineering performance test."

The Bay City test was not *completely* successful, however: the thermal desorption unit, which separates the contaminants from the soil, did not perform to design specifications. The EPA applications analysis report concluded: "The combination of material handling problems and inadequate organics desorption showed a need for further development."

Martin Hassenbach, a spokesperson for the company's marketing department, describes how Eco-Logic has addressed the problem. After the 1992 tests, Hassenbach explains, the company went back to the drawing board to design a new device to replace the thermal desorption unit. The device, called a thermal desorption mill (TDM), uses rotating steel balls to break up the soil at the time it is being heated. "We had these big clumps of soil that were not breaking down properly," he said. "We could get at the contamination outside, on the surface of the soil, but we could not desorb the contamination inside the lumps." With the new design, the soil or sediment is ground into a powder during

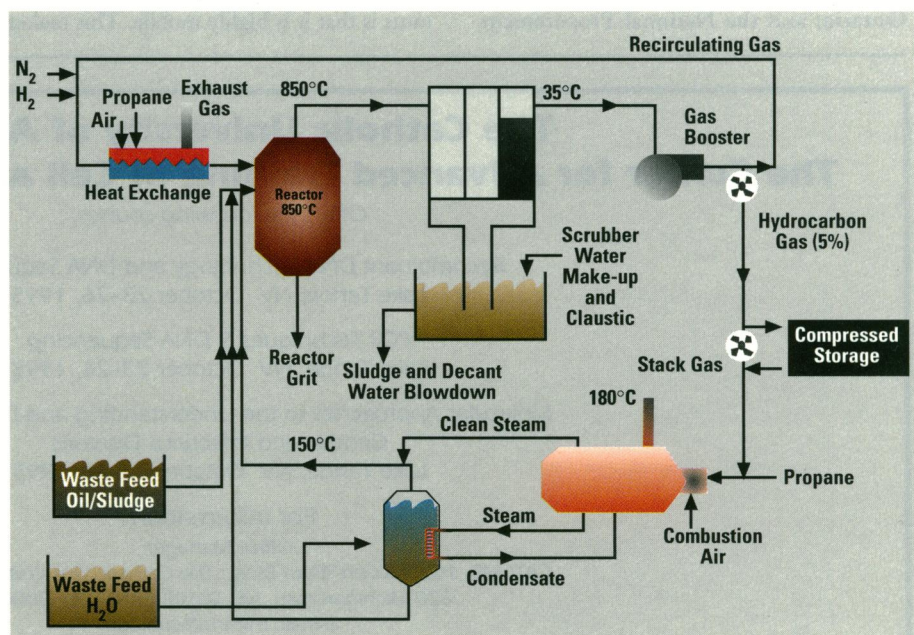
the heating process. The soil is passed through without oxygen into an enclosed device that is heated and supplied with hydrogen-rich methane gas from the reactor. Hydrogen strips the contaminants from the soil. Contaminants are then carried to a reactor where they are broken down into methane gas. The remaining methane gas is recirculated through the TDM to heat the unit. With the new TDM, the amount of toxic materials that remains in the soil is reduced to the low parts per billion range. Says Swain, "Since the Toxic Substances Control Act demands 1 part per million, we are now 1,000 times better than that."

On 15 July 1994, the EPA released a detailed "Technology Evaluation Report" of the Superfund trial program which independently verified previous reports on the success of the Bay City project. Based on the operating experience and test results at Bay City, commercial-scale process units were constructed and are now being used.

Gordon Evans, economist and EPA project manager for Eco-Logic's testing program in Bay City, stated, "The bottom line is that the machine does what it's advertised to do."

The Costs of Progress

Evans says, however, that the costs of the process are currently higher than incineration. "According to our studies, if we use Eco-Logic to dispose of 30,000 gallons of oil [contaminated with PCBs], it will cost \$1,800 a ton. . . . At this point, it costs between \$1,200 to \$1,300 a ton for incineration."



Keeping to itself. A closed-loop destruction process means no uncontrolled emissions.

Eco-Logic

Responding to this analysis, Swain suggests that it does not factor in the additional expenses of waste transportation to and from the incinerator: "Those costs are eliminated with our technology," says Swain. "Residue ash requires proper disposal, usually in a landfill, a procedure that adds to the cost and may be limited because available landfills are rapidly filling up."

Swain adds, "Operating economies to treat water-bearing waste are eventually expected to be three to five times cheaper than incineration technologies of comparable capacities. Incineration technologies consume large amounts of energy to heat up the water component to combustion temperature. Additionally, because incineration technologies utilize air for combustion and must destroy all the organic matter, they often require 10 times the volume of the Eco-Logic process for the same residence time of reaction."

William A. Suk, chief of the Chemical Exposures and Molecular Biology Branch of the NIEHS's Division of Extramural Research, calls the Eco-Logic process, "an interesting technology and one that probably has merit." However, Suk adds, "Hazardous waste is a mixture. In order to eliminate PCBs and hydrocarbons, you don't get rid of metals and visa versa. No one process does it all."

Out of Site, Out of Mind

Eco-Logic has already begun to be used around the world. The company has signed with General Motors of Ontario, Canada, to dispose of that company's wastes; Dofasco Steel will use the process to clean up a PCB-laden mine in northern Ontario; and the National Procurement

SUGGESTED READING

U.S. EPA. Eco-Logic International gas-phase chemical reduction process and thermal desorption unit, middleground landfill, Bay City, MI. A Superfund Innovative Technology Evaluation. EPA/540/SR-93/522. Cincinnati, OH: Environmental Protection Agency, 1994.

U.S. EPA. Twentieth annual RREL research symposium: abstract proceedings. The Eco-Logic gas-phase chemical reduction process. EPA/600/R-94/011. Cincinnati, OH: Environmental Protection Agency, 1994.

Roy Kimberly A. Thermo-chemical reduction process destroys complex compounds. *Hazmat World* Dec: 77-79 (1992).

Development Program of the Australian Department of Environmental Protection is planning to use the process to destroy 200 tons of hazardous pesticides currently stored in Western Australia.

Incinerators run better—environmentally and economically—when they run continuously, which requires a steady stream of waste. Thus, in order to keep running, an incinerator may be forced to take in waste from a number of different communities. This raises the issue of fairness. Should one community become the disposal site for others? Or, should one community accept the risks of an incinerator malfunctioning? Local citizens fear that a design on paper, however promising, may not translate into adequate functioning once an incinerator is on-line. An incinerator site also leads to other irritants such as noise, truck traffic, and unpleasant odors. And communities that house incinerators usually see their property values go down.

One advantage of the Eco-Logic apparatus is that it is highly mobile. This makes

it attractive to communities that are troubled by the presence of incinerators. Once the job is done, the machine is hoisted on top of a large trailer and moved on to the next site. The apparatus is contained on two 45-foot drop-deck flatbed trailers. An additional trailer, housing the on-line mass spectrometer, the process control unit, and other analytical units completes the equipment. Setup takes only a few days, and the minimum run may be less than a single unit's daily capacity.

Swain believes it is just a matter of time before the process is fully accepted. Current demand is greater than the company's supply; sales are now projected well into 1996. "For the kind of thing we do—dispose of any organic contaminant in any matrix in any concentration—I know of no other technology presently that can do it," Swain says. "Eventually people will see this as part of the future."

Liane Clorfene Casten

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For information:

Office Manager

CATCMB, 103, McCort-Ward Bldg., The Catholic University of America
620 Michigan Ave., NE, Washington, DC 20064
e-mail: millerm@cua.edu